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Claims

[c1] A control system for an automotive vehicle comprising:
a camera-based vision system generating image signals;
a rollover control system; and
a controller coupled to the camera system and the rollover control system, said controller generating a dynamic vehicle characteristic signal in response to the image signals, said controller controlling the rollover control system in response to the dynamic vehicle control signal.

[c2] A control system as recited in claim 1 wherein the dynamic vehicle characteristic signal comprises a vehicle roll direction angle signal.

[c3] A control system as recited in claim 1 further comprising a yaw control system, wherein said controller chooses between the yaw stability control system or the rollover control system in response to the dynamic vehicle characteristic.

[c4] A control system as recited in claim 1 wherein the dynamic vehicle characteristic signal comprises a vehicle pitch angle signal.

[c5] A control system as recited in claim 1 wherein the dynamic vehicle characteristic signal comprises a lateral velocity signal.

[c6] A control system as recited in claim 1 wherein said controller determines an aggressive driving status or loss of control status in response to the lateral velocity signal, said controller activating a yaw stability control system or a rollover control system in response to determining the aggressive driving status or loss of control status.

[c7] A control system as recited in claim 1 wherein the dynamic vehicle characteristic signal comprises a longitudinal velocity signal.

[c8] A control system as recited in claim 1 wherein the dynamic vehicle characteristic signal comprises a road departure signal.

[c9] A control system as recited in claim 1 further comprising a yaw stability control signal, said controller controlling the yaw stability control system in response to the road departure signal.

[c10] A control system as recited in claim 1 wherein the dynamic vehicle characteristic signal comprises an in-path object signal.

[c11] A control system as recited in claim 1 wherein the dynamic vehicle characteristic signal comprises a wheel lifted signal.

[c12] A control system as recited in claim 1 wherein the dynamic vehicle characteristic signal comprises a body-to-road angle signal.

[c13] A control system as recited in claim 12 wherein the controller enters a wheel lift determination when the body-to-road angle is above a predetermined threshold.

[c14] A control system as recited in claim 1 further comprising generating a plurality of wheel speeds from a wheel speed sensors, wherein said controller identifying a wheel slip condition or wheel lock condition, said controller generating a longitudinal speed signal from the dynamic vehicle characteristic signal during the wheel slip or wheel lock condition.

[c15] A control system as recited in claim 1 wherein the dynamic vehicle characteristic signal comprises a body side slip signal.

[c16] A control system as recited in claim 1 wherein the dynamic vehicle characteristic signal comprises a rotational moment of inertia signal.

[c17] A control system as recited in claim 1 wherein the camera system comprises a stereo pair of cameras.

[c18] A control system as recited in claim 1 wherein the camera system comprises a front camera and side camera.

[c19] A control system as recited in claim 1 wherein the camera system comprises a rear camera and side camera.

[c20] A control system as recited in claim 1 further comprising a radar, lidar, or sonar-based system generating environmental sensing signals; and said controller generating a dynamic vehicle characteristic signal in response to the image signals and the environmental sensing signals.

[c21] A method of controlling a rollover control system of automotive vehicle comprising:
generating an image signal;
generating a dynamic vehicle characteristic signal in response to the image signal; and
controlling the rollover control system in response to the dynamic vehicle control signal.

[c22] A method as recited in claim 21 wherein generating a dynamic vehicle characteristic signal comprises generating a vehicle roll direction angle signal.

[c23] A method as recited in claim 21 further comprising a yaw

control system, choosing between the yaw stability control system or the rollover control system in response to the dynamic vehicle characteristic signal.

[c24] A method as recited in claim 21 wherein generating a dynamic vehicle characteristic signal comprises generating a vehicle pitch angle signal.

[c25] A method as recited in claim 21 wherein generating a dynamic vehicle characteristic signal comprises generating a lateral velocity signal.

[c26] A method as recited in claim 25 further comprising determining an aggressive driving status or loss of control status in response to the lateral velocity signal, said controller activating a yaw stability control system or a rollover control system in response to determining the aggressive driving status or loss of control status.

[c27] A method as recited in claim 21 wherein generating a dynamic vehicle characteristic signal comprises generating a longitudinal velocity signal.

[c28] A method as recited in claim 21 wherein generating a dynamic vehicle characteristic signal comprises generating a road departure signal.

[c29] A method as recited in claim 28 further comprising a yaw

stability control signal, said further comprising controlling the yaw stability control system in response to the road departure signal.

[c30] A method as recited in claim 21 wherein generating a dynamic vehicle characteristic signal comprises generating an in-path object signal.

[c31] A method as recited in claim 21 wherein generating a dynamic vehicle characteristic signal comprises generating a wheel lifted signal.

[c32] A method as recited in claim 21 wherein generating a dynamic vehicle characteristic signal comprises generating a body-to-road angle signal.

[c33] A method as recited in claim 21 further comprising entering a wheel lift determination when the body-to-road angle is above a predetermined threshold.

[c34] A method as recited in claim 21 further comprising generating a plurality of wheel speeds from a wheel speed sensors, identifying a wheel slip condition or wheel lock condition, generating a longitudinal speed signal in response to the dynamic vehicle characteristic signal during the wheel slip or wheel lock condition.

[c35] A method as recited in claim 21 wherein generating a

dynamic vehicle characteristic signal comprises generating a body side slip signal.

[c36] A control system for an automotive vehicle comprising:
a camera-based vision system generating image signal;
a dynamic control system; and
a controller coupled to the camera system and the dynamic control system, said controller generating an aggressive driving signal or loss of control signal in response to the image signal, said controller increasing the controlling the dynamic control system entry threshold in response to the aggressive driving signal and reducing the dynamic control system entry threshold in response to the loss of control signal.

[c37] A control system as recited in claim 36 wherein said controller determines a lateral velocity signal in response to the image signal, said controller generating an aggressive driving signal or loss of control signal in response to the lateral velocity signal.

[c38] A control system as recited in claim 36 wherein the dynamic control system comprises a yaw stability control system.

[c39] A control system as recited in claim 36 wherein the dynamic control system comprises a roll stability control

system.

[c40] A control system as recited in claim 36 wherein the loss of control signal comprises a road departure signal.

[c41] A control system as recited in claim 36 wherein the camera-based vision system comprises a front mounted camera.

[c42] A control system as recited in claim 36 wherein the camera-based vision system comprises a front mounted camera and a side mounted camera.

[c43] A control system as recited in claim 36 wherein the camera-based vision system comprises a rear mounted camera.

[c44] A method of controlling a dynamic control system of a vehicle comprising:
generating image signal;
generating an aggressive driving signal or loss of control signal in response to the image signal;
increasing an entry threshold of the dynamic control system in response to the aggressive driving signal;
reducing the entry threshold of the dynamic control system in response to the loss of control signal; and
controlling the vehicle with the dynamic control system.

[c45] A method as recited in claim 44 wherein generating an image signal comprises generating an image signal from a stereo pair of cameras.

[c46] A method as recited in claim 44 wherein generating an image signal comprises generating an image signal from a front mounted camera and a side mounted camera.

[c47] A method as recited in claim 44 wherein generating an image signal comprises generating an image signal from a rear mounted camera and a side mounted camera.

[c48] A method as recited in claim 44 wherein the loss of control signal comprises a road departure signal.

[c49] A method of controlling a dynamic control system of a vehicle comprising:
generating image signal;
generating an aggressive driving signal in response to the image signal;
increasing the controlling an entry threshold of the dynamic control system in response to the aggressive driving signal; and
controlling the vehicle with the dynamic control system.

[c50] A method as recited in claim 49 wherein generating an image signal comprises generating an image signal from a stereo pair of cameras.

[c51] A method as recited in claim 49 wherein generating an image signal comprises generating an image signal from a front mounted camera and a side mounted camera.

[c52] A method as recited in claim 49 wherein generating an image signal comprises generating an image signal from a rear mounted camera and a side mounted camera.

[c53] A method as recited in claim 49 wherein the loss of control signal comprises a road departure signal.

[c54] A method of controlling a dynamic control system of a vehicle comprising:
generating image signal;
generating a loss of control signal in response to the image signal;
reducing the entry threshold of the dynamic control system entry threshold in response to the loss of control signal; and
controlling the vehicle with the dynamic control system.

[c55] A method as recited in claim 49 wherein generating an image signal comprises generating an image signal from a stereo pair of cameras.

[c56] A method as recited in claim 49 wherein generating an image signal comprises generating an image signal from

a front mounted camera and a side mounted camera.

[c57] A method as recited in claim 49 wherein generating an image signal comprises generating an image signal from a rear mounted camera and a side mounted camera.

[c58] A method as recited in claim 49 wherein the loss of control signal comprises a road departure signal.

[c59] A control system for an automotive vehicle comprising:
a plurality of wheel speed sensors generating wheel speed signals;
a camera-based vision system generating image signal;
a radar, lidar, or sonar-based system generating environmental sensing signals;
a dynamic control system; and
a controller coupled to the camera system and the rollover control system, said controller determining a first vehicle speed from the wheel speed sensor signals, said controller controlling the dynamic control system in response to the first wheel speed, determining a wheel lock or wheel slip condition from the wheel speed sensors, generating a second vehicle speed in response to the image signal, said controller controlling the dynamic control system in response to the second vehicle speed during a wheel lock or wheel slip condition.

[c60] A control system as recited in claim 59 wherein the dynamic control system comprises an anti-lock brake system.

[c61] A control system as recited in claim 59 wherein the dynamic control system comprises a traction control system.

[c62] A control system as recited in claim 59 wherein the dynamic control system comprises a roll stability control system.

[c63] A control system as recited in claim 59 wherein the dynamic control system comprises a yaw stability control system.

[c64] A method of operating a dynamic control system of an automotive vehicle comprising:
generating wheel speed signals from a plurality of wheel speed sensors;
generating an image, radar, lidar or sonar-based signal;
determining a first vehicle speed from the wheel speed sensor signals;
controlling the dynamic control system in response to the first wheel speed;
determining a wheel lock or wheel slip condition from the wheel speed sensors;

generating a second vehicle speed in response to the image, radar, lidar or sonar-based signal; and controlling the dynamic control system in response to the second vehicle speed during a wheel lock or wheel slip condition.

[c65] A method as recited in claim 64 wherein controlling the dynamic control system comprises controlling a yaw control system.

[c66] A method as recited in claim 64 wherein controlling the dynamic control system comprises controlling a rollover control system.

[c67] A method as recited in claim 64 wherein controlling the dynamic control system comprises controlling a traction control system.

[c68] A method as recited in claim 64 wherein controlling the dynamic control system comprises controlling an anti-lock brake system.

[c69] A control system for an automotive vehicle comprising:
means to determine the longitudinal velocity of the vehicle;
a camera-based vision system generating image signal;
a dynamic control system; and
a controller coupled to the camera system and the dy-

namic control system, said controller determining a lateral velocity from the image signal, said controller determining a side slip angle in response to the lateral velocity and the longitudinal velocity, said controller controlling the dynamic control system in response to the side slip angle.

[c70] A control system as recited in claim 69 wherein the dynamic control system comprises an anti-lock brake system.

[c71] A control system as recited in claim 69 wherein the dynamic control system comprises a traction control system.

[c72] A control system as recited in claim 69 wherein the dynamic control system comprises a roll stability control system.

[c73] A control system as recited in claim 69 wherein the dynamic control system comprises a yaw stability control system.

[c74] A method of operating a dynamic control system of an automotive vehicle comprising:
determining a longitudinal vehicle velocity;
generating image, radar, or lidar-based signals;
determining a lateral velocity from the image, radar, or

lidar-based signals;
determining a side slip angle from the longitudinal vehicle velocity and the lateral velocity; and
controlling the dynamic control system in response to the side slip angle.

[c75] A method as recited in claim 74 wherein determining a longitudinal velocity comprises determining a longitudinal velocity from a wheel speed sensor.

[c76] A method as recited in claim 74 wherein determining a longitudinal velocity comprises determining a longitudinal velocity from the image, radar, lidar, or sonar-based signals.

[c77] A method as recited in claim 74 wherein controlling the dynamic control system comprises controlling a yaw control system.

[c78] A method as recited in claim 74 wherein controlling the dynamic control system comprises controlling a rollover control system.

[c79] A method as recited in claim 74 wherein controlling the dynamic control system comprises controlling a traction control system.

[c80] A method as recited in claim 74 wherein controlling the

dynamic control system comprises controlling an anti-lock brake system.

[c81] A control system for an automotive vehicle on a road surface comprising:
a camera-based vision system generating image signals;
a dynamic control system;
a controller coupled to the camera system and the rollover control system, said controller generating a low mu identification signal of the road surface in response to the image signal, said controller controlling a dynamic control system in response to the low mu identification signal.

[c82] A control system as recited in claim 81 wherein said controller generates a quantification of the low mu identification signal.

[c83] A control system as recited in claim 82 wherein the quantification corresponds to snow and rain.

[c84] A control system as recited in claim 81 wherein the dynamic control system comprises an anti-lock brake system.

[c85] A control system as recited in claim 81 wherein the dynamic control system comprises a traction control system.

[c86] A control system as recited in claim 81 wherein the dynamic control system comprises a roll stability control system.

[c87] A control system as recited in claim 81 wherein the dynamic control system comprises a yaw stability control system.

[c88] A method of controlling an automotive vehicle on a road surface comprising:
generating image signals;
generating a low mu identification signal of the road surface in response to the image signal; and
controlling a dynamic control system in response to the low mu identification signal.

[c89] A method as recited in claim 88 further comprising quantifying the low mu identification signal to form a mu quantification, wherein controlling comprises controlling a dynamic control system in response to the quantification.

[c90] A method as recited in claim 88 wherein the quantification corresponds to snow and rain.

[c91] A method as recited in claim 88 wherein controlling the dynamic control system comprises controlling a yaw

control system.

[c92] A method as recited in claim 88 wherein controlling the dynamic control system comprises controlling a rollover control system.

[c93] A method as recited in claim 88 wherein controlling the dynamic control system comprises controlling a traction control system.

[c94] A method as recited in claim 88 wherein controlling the dynamic control system comprises controlling an anti-lock brake system.

[c95] A control system for an automotive vehicle comprising:
a camera-based vision system generating image signals;
a dynamic control system having a first control strategy and a second control strategy; and
a controller coupled to the camera system and the rollover control system, said controller changing a first control strategy to a second control strategy in response to the image signal and controlling a dynamic control system in response to the second control strategy.

[c96] A control system as recited in claim 95 wherein the dynamic control system comprises an anti-lock brake system.

[c97] A control system as recited in claim 95 wherein the dynamic control system comprises a traction control system.

[c98] A control system as recited in claim 95 wherein the dynamic control system comprises a roll stability control system.

[c99] A control system as recited in claim 95 wherein the dynamic control system comprises a yaw stability control system.

[c100] A method of operating an automotive vehicle comprising:
generating an image signals from a vision system;
determining the presence of an in-path hazard in response to the image signal;
changing a first control strategy to a second control strategy in response to the image signal; and
controlling a dynamic control system in response to the second control strategy.

[c101] A method as recited in claim 100 wherein controlling the dynamic control system comprises controlling a yaw control system.

[c102] A method as recited in claim 100 wherein controlling the dynamic control system comprises controlling a rollover

control system.

[c103] A method as recited in claim 100 wherein controlling the dynamic control system comprises controlling a traction control system.

[c104] A method as recited in claim 100 wherein controlling the dynamic control system comprises controlling an anti-lock brake system.

[c105] A control system for an automotive vehicle comprising:
a camera-based vision system generating image signals;
a dynamic control system; and
a controller coupled to the camera system and the rollover control system, said controller generating a tripping hazard signal in response to the image signal and controlling a dynamic control system in response to the tripping hazard signal.

[c106] A control system as recited in claim 105 wherein the vision system comprises a stereo pair of cameras.

[c107] A control system as recited in claim 105 wherein the vision system comprises a front mounted camera and a side mounted camera.

[c108] A control system as recited in claim 105 wherein the vision system comprises a side mounted camera.

[c109] A control system as recited in claim 105 wherein the dynamic control system comprises an anti-lock brake system.

[c110] A control system as recited in claim 105 wherein the dynamic control system comprises a traction control system.

[c111] A control system as recited in claim 105 wherein the dynamic control system comprises a roll stability control system.

[c112] A control system as recited in claim 105 wherein the dynamic control system comprises a yaw stability control system.

[c113] A control system as recited in claim 105 wherein the dynamic control system comprises a suspension control system, said controller controlling the suspension to lower a center of gravity of the vehicle.

[c114] A control system as recited in claim 105 further comprising a warning device, said controller controlling the warning device in response to the tripping hazard signal.

[c115] A control system as recited in claim 114 wherein the warning device comprises an audible warning device.

[c116] A control system as recited in claim 114 wherein the warning device comprises a visual warning device.

[c117] A method of preventing a tripped rollover in an automotive vehicle comprising:
generating an image, radar, lidar, or sonar-based signal;
identifying a tripping hazard and generating a tripping hazard signal in response to the image, radar, lidar, or sonar-based signal; and
generating a warning signal from a warning device in response to the tripping hazard signal.

[c118] A method as recited in claim 117 wherein generating an image signal comprises generating an image signal from a stereo pair of cameras.

[c119] A method as recited in claim 117 wherein generating an image signal comprises generating an image signal from a front mounted camera and a side mounted camera.

[c120] A control system as recited in claim 105 wherein generating comprises generating the image, radar, lidar, or sonar-based signal from a forward mounted system.

[c121] A control system as recited in claim 105 wherein generating comprises generating the image, radar, lidar, or sonar-based signal from a side mounted system.

[c122] A control system as recited in claim 105 wherein generating comprises generating the image, radar, lidar, or sonar-based signal from a rear mounted system.

[c123] A method as recited in claim 117 further comprising controlling a dynamic control system in response to the tripping hazard signal.

[c124] A method of preventing a tripped rollover in an automotive vehicle having a center of gravity, said method comprising:
generating an image, radar, lidar, or sonar-based signal;
identifying a tripping hazard and generating a tripping hazard signal in response to the image, radar, lidar, or sonar-based signal; and
changing the center of gravity to the vehicle counter to a roll direction in response to the tripping hazard signal.

[c125] A method as recited in claim 124 wherein changing the center of gravity comprises lowering an active suspension.

[c126] A method as recited in claim 125 wherein lowering an active suspension comprises lowering the active suspension on one side of the vehicle.

[c127] A method as recited in claim 124 wherein changing the center of gravity comprises raising an active suspension.

[c128] A method as recited in claim 124 wherein changing comprises raising an active suspension on one side of the vehicle.

[c129] A method as recited in claim 124 wherein changing the center of gravity comprises lowering an active suspension on one side of the vehicle and raising the active suspension on the other side of the vehicle.

[c130] A method as recited in claim 124 wherein generating an image signal comprises generating an image signal from a stereo pair of cameras.

[c131] A method as recited in claim 124 wherein generating an image signal comprises generating an image signal from a front mounted camera and a side mounted camera.

[c132] A control system as recited in claim 105 wherein generating comprises generating the image, radar, lidar, or sonar-based signal from a forward mounted system.

[c133] A control system as recited in claim 105 wherein generating comprises generating the image, radar, lidar, or sonar-based signal from a side mounted system.

[c134] A control system as recited in claim 105 wherein generating comprises generating the image, radar, lidar, or sonar-based signal from a rear mounted system.

[c135] A control system in an automotive vehicle comprising:
a camera-based vision system generating an image signals;
a dynamic control system;
an integrated measurement unit generating sensor signals, said sensor signals comprising a drift error; and
a controller coupled to the camera-based vision system and the integrated measurement unit, said controller correcting a drift error in the sensor signals in response to the image signals to form corrected sensor signals, said controlling the dynamic control system in response to the corrected sensor signals.

[c136] A control system as recited in claim 135 wherein the camera system comprises a pair of cameras.

[c137] A control system as recited in claim 135 wherein the camera system comprises a front mounted pair of cameras.

[c138] A control system as recited in claim 135 wherein the camera system comprises a front mounted camera and a side mounted camera.

[c139] A control system as recited in claim 135 wherein the camera system comprises a rear mounted camera and a side mounted camera.

[c140] A control system as recited in claim 135 wherein the dynamic control system comprises an anti-lock brake system.

[c141] A control system as recited in claim 135 wherein the dynamic control system comprises a traction control system.

[c142] A control system as recited in claim 135 wherein the dynamic control system comprises a roll stability control system.

[c143] A control system as recited in claim 135 wherein the dynamic control system comprises a yaw stability control system.

[c144] A method of controlling an automotive vehicle comprising:

generating an image signals from a vision system;

generating sensor signals from an integrated measurement unit wherein said sensor signal comprises a drift error;

correcting a drift error in the sensor signals in response to the image signals to form corrected sensor signals; and

controlling a dynamic control system in response to the corrected sensor signals.

[c145] A roll stability control system for an automotive vehicle comprising:

an active anti-roll bar system;

a camera-based vision system generating image signal; and

a controller coupled to the active anti-roll bar system and the camera-based vision system, said controller generating a roll attitude signal indicative of an impending rollover of the vehicle in response to the image signal and controlling the active anti-roll bar to prevent the vehicle from rolling over in response to the roll attitude signal.

[c146] A roll stability control system as recited in claim 145 further comprising a brake actuator coupled to the controller, said controller controlling the active anti-roll bar system and the brake actuator to prevent the vehicle from rolling over.

[c147] A roll stability control system as recited in claim 145 wherein the active anti-roll bar system comprises a front active anti-roll bar.

[c148] A roll stability control system as recited in claim 145 wherein the active anti-roll bar system comprises a rear active anti-roll bar.

[c149] A roll stability control system as recited in claim 145 wherein the active anti-roll bar system comprises a front active anti-roll bar and a rear anti-roll bar.

[c150] A method of controlling roll stability of an automotive vehicle having a front and rear brake system, and a front and rear active anti-roll bar system comprising the steps of:
generating image signals from a vision system;
determining a roll angle estimate in response to the image signals;
controlling an active anti-roll bar system in response to the roll angle estimate; and
controlling a brake system in response to the roll angle estimate to provide a predetermined tire force vector.

[c151] A method as recited in claim 150 wherein controlling an active anti-roll bar system comprises controlling a front and rear active anti-roll bar in response to the roll angle estimate.

[c152] A method as recited in claim 150 wherein controlling a brake system comprises controlling a front and rear brake controller in response to the roll angle estimate to provide a predetermined tire force vector.

[c153] A control system for an automotive vehicle comprising:

a level-based system;

a camera-based vision system generating image signal; and

a controller coupled to the active anti-roll bar system and the camera-based vision system, said controller generating a pitch attitude signal and controlling the level-based in response to the pitch attitude signal.

[c154] A control system as recited in claim 153 wherein the level based system comprises a suspension leveling system.

[c155] A control system as recited in claim 153 wherein the level based system comprises a headlight adjustment system.

[c156] A control system as recited in claim 153 wherein the controller determines a roll angle in response to the image signals, said controller controlling the level-based system in response to the roll angle and the pitch angle estimate.

[c157] A method of controlling an automotive vehicle comprising:

generating image signals from a vision system;

determining a pitch angle estimate in response to the image signals; and

controlling a level-based system in response to the pitch angle estimate.

[c158] A method as recited in claim 157 wherein the level based system comprises a suspension leveling system.

[c159] A control system as recited in claim 157 wherein the level based system comprises a headlight adjustment system.

[c160] A method as recited in claim 157 further comprising determining a roll angle in response to the image signals and wherein controlling comprises controlling a level-based system in response to the pitch angle estimate and the roll angle.